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ABSTRACT

Efforts to create instructional materials which would be cognitively appealing to students demonstrating aptitude for figurally, verbally, or symbolically oriented materials are described. Students enrolled in preservice freshman level mathematics content courses for prospective elementary school teachers were given a battery of tests designed to measure their figural, semantic (verbal), and symbolic aptitudes; they then studied a short unit on network tracing that supposedly was written in the figural, verbal, or symbolic mode. Criterion variables were scores on tests of immediate retention, retention after one week, and retention after four weeks. Analysis showed that students with high figural aptitude did significantly better on the figural lesson than did students with low figural aptitudes. High verbal and high symbolic subjects did not perform significantly higher on the figural lesson than did low verbal and low symbolic students respectively. There were corresponding results for the verbal lesson. No definitive results were derived from the symbolic lesson. (Author/DT)

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Introduction

This report describes initial efforts to design mathematical lessons geared to specified cognitive aptitudes of learners. These lessons will then be used to study aptitude-treatment interactions in learning the mathematical concept of network tracing.

The topics of cognitive style and aptitude-treatment interaction (ATI) have recently interested educational psychologists and educational researchers. Gagné (1960) suggested that the addition of directed numbers might be taught experimentally by three modes designed to employ a spatial, numerical, or verbal mode of presentation, respectively. He conjectured that Ss who score higher on a test of spatial ability than on a test of verbal or numerical ability will learn a concept more readily via spatially oriented materials than when verbally or symbolically oriented instructional materials are employed. Similarly he predicted that Ss who score relatively higher in verbal ability will learn a concept more readily using verbally oriented materials than by using spatially or symbolically oriented materials and that Ss who score relatively higher in numerical ability will learn a concept more readily using symbolically oriented instruction than by using spatially or verbally oriented instruction. Gagné's hypothesis is illustrated by the three general cases in Figure 1.

Insert Figure 1 about here

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In Figure 1, T_A, T_B, and T_C represent the regression lines for treatments A, B, and C, respectively. For Gagne's hypothesis one of the treatments is spatially oriented, one is verbally oriented, and one is symbolically oriented. In Figure 1a, Ss who score higher than X_1 would receive treatment T_A, Ss who score lower than X_2 would receive treatment T_C, and Ss with scores between X_1 and X_2 would receive treatment T_B. In Figure 1b, Ss who score higher than X_3 would receive treatment T_A, Ss who score lower than X_3 would receive treatment T_C, and no S would receive treatment T_B. In Figure 1c, all Ss would receive treatment T_A.

Bracht and Glass (1970) attempted to partially test Gagne's hypothesis by using two instructional techniques instead of three. The possible regression lines for two instructional techniques are shown in Figure 2. The instructional modes employed were spatially oriented

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Insert Figure 2 about here

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instruction and verbally oriented instruction of the addition of signed numbers. Ss with middle or high ability on both tests performed equally well with the alternative treatments. Some results indicated that the verbal treatment was better for Ss with low spatial ability and that the spatial treatment was superior for Ss with low verbal ability. These results however, were not conclusive. One of the reasons for these inconclusive results could have been with the materials. Bracht and Glass (1970) attempted to construct the spatial (verbal) materials so that spatial (verbal) reasoning would be most important in understanding the concepts and verbal (spatial) ability would be relatively unrelated to performance. However, they apparently did not attempt to determine the degree to which they were successful in their attempts.

Many studies of cognitive style of learning and ATI have been conducted (for example: Bracht, 1970; Berliner, 1971 and 1972; Carry, 1968; Davis, J.B., 1968; Davis, J.K., 1972; Scott, 1972; Webb, 1971 and 1972; Hancock, 1972 and 1973; and Eastman 1972.. The majority of thesestudies were unsuccessful in their attempts to find meaningful disordinal interactions. It is interesting to note that the study of Eastman (1972) was a follow-up of Webb's (1971) study which in turn was a follow-up of Carry's (1968) study. Eastman was successful in modifying the other two studies enough to find a significant aptitude-treatment interaction. "In many studies, the alternative treatment was only some minor modification of some original instructional program. Experimenters need to move beyond this level and develop alternative treatments from a conception of the abilities which are relavent to successful performance in the alternative treatments." (Bracht, 1970, p. 639) Thus, before a significant study of ATI can be undertaken, alternative treatments that conform to the personological variables under consideration need to be developed. This paper reports on efforts to construct this type of alternative treatments.

Personological Variables

The personological variables investigated in this study were selected from among the mental factors identified in Guilford's Structure-of-Intellect (SI) model. (Guilford, 1967) Guilford's SI model is a three-way classification of intellectual abilities designed to organize intellectual-aptitude factors according to the operation, content, and product of a given kind of intellectual act. According to Guilford's model there exist 120 mental factors. It was necessary to select a subset of these 120 mental factors that would be small

enough to allow for the construction of a battery of tests that could be administered in a reasonable length of time.

Along the operation dimension only the category of cognition (C) was selected for investigation. Cognition is "immediate discovery, awareness, rediscovery, or recognition or information in various forms; comprehension or understanding." (Guilford and Hoepfner, 1966) The operations categories of memory, divergent production, convergent production, and evaluation were not regarded as any less important, but rather as being less relevant at this stage of the research.

The selection of the figural (F), semantic (M), and symbolic (S) categories along the content dimension was closely related to the choice of modes of presentation for the respective instructional programs. Figural content is "information in concrete form, as perceived or as recalled possibly in the form of images . . . Visual spatial information is figural." Symbolic content is "information in the form of denotative signs, having no significance in and of themselves, such as letters, numbers . . ." Semantic content is "information in the form of meanings to which words commonly become attached, hence most notable in verbal thinking and in verbal communication but not identical with words . . ." (Guilford and Hoepfner, 1966)

Along the products dimension it was decided to select the categories of units (U), classes (C), and relations (R). To have included others would have necessitated the construction of a battery of tests that would have required an excessive amount of time to administer. Guilford and Hoepfner define units as "relatively segregated or circumscribed items of information having 'thing' character." Classes are defined as "conceptions underlying sets of items of information grouped by virtue of their common properties." Relations are defined to be "connections

between items of information based upon variables or points of contact that apply to them."

Hence, the mental factors chosen for investigation in this study represents a 3 x 3 x 1 corner of the SI model. The mental factors, their trigram representation, a definition of each factor, the name of the test used to measure each mental factor, the reliability of the test reported by the publisher, and a brief description of the test is given below. Tests designed to measure SI abilities were developed in conjunction with the Aptitude Research Project at the University of Southern California.

Cognition of figural units, (CFU), the ability to "close" figural information to perceive a complete visual form, Close-ups, 0.66, Close-up photographs of portions of familiar objects were presented and the subject was asked to identify the object.

Cognition of figural classes, (CFC), the ability to recognize classes of figural items of information, Figure Classification, 0.61, subject was to recognize classes of three sets of figures each, then assign given figures to the classes.

Cognition of figural relations,(CFR), the ability to recognize figural relations between forms, Figure Matrix, 0.60, from multiple choices, subject was to select a figure to fill a matrix cell in a 3 x 3 matrix having different relations in columns and rows.

Cognition of semantic units, (CMU), the ability to comprehend the meaning of words or ideas, Word Completion, 0.82, subject was asked to write a synonym or short definition for given word.

Cognition of semantic classes, (CMC), the ability to recognize common properties of words or ideas, Sentence Classification, 0.72, subject had to decide whether each given sentence conveyed a fact, possibility, or a name.

Cognition of semantic relations, (CMR), the ability to see relations between ideas or meanings of words, Word Matrix Test, 0.59, subject was required to discover the relation in rows and columns, then to supply the missing word.

Cognition of symbolic units, (CSU) the ability to recognize graphic symbolic units, such as words, Omelet Test, 0.68, subject was to recognize a word whose letters have been scrambled.

Cognition of symbolic classes, (CSC), the ability to recognize common properties in sets of symbolic information, Number-Group Naming, 0.67, subject was to state the property common to a group of three numbers.

Cognition of symbolic relations, (CSR), the ability to see relations between items of symbolic information, Word Relations, 0.78, a kind of analogies test in which the items of information related are words, the relations being in the form of spelling or alphabetical properties.

In addition to the nine mental factors listed above, three other variables of interest were considered in this study. These variables were obtained by combining the scores of a subject on each of the three tests related to the three categories along the content dimension. That is, the sum of all the scores on tests of figural ability was regarded as a new variable denoting total cognition of figural content (CF-T). A similar variable represented the total of scores involving symbolic content (CS-T) and semantic content (SN-T). This process resulted in a set of twelve independent variables being considered in this study.

Tests were arranged into a two-part battery on the basis of commonality of scoring methods.

Subjects

The subjects were undergraduate students enrolled in preservice freshman level mathematics content courses for prospective elementary

school teachers Spring and Fall Quarters 1972 and Winter Quarter 1972-73 at Eastern Illinois University. As is typical of these courses, the vast majority (approximately 95%) of the students were females.

Instructional Materials

The instructional materials were on the mathematical concept of network tracing. This concept was selected because it was a topic that could be learned in less than thirty-five minutes (this would leave at least ten minutes for students to complete the learning test) and it was a topic that was probably unfamiliar to the Ss. Furthermore, it was felt that this topic would readily lend itself to instruction from the figural, verbal, and symbolic modes.

The first stage of the project was to construct instructional materials on network tracing which were, in the author's opinion, figurally oriented. Subsequent stages involved the development of instructional materials on network tracing which were, in the experimenters' opinion, verbally or symbolically oriented. The "figurally oriented" instructional materials consisted of five pages of self-instructional text. Each page required several short responses from Ss. The "verbally oriented" and the "symbolically oriented" instructional materials were of a similar design.

Three similar 16-item tests were constructed -- one to measure immediate learning, one to measure retention one week after instruction, and one to measure retention four weeks after instruction. The first twelve items on each test were multiple choice items. The first eight items of each test measured whether Ss could determine whether a vertex

was even or odd, the next four items measured whether Ss could determine whether or not a network was traceable. On the last four items, Ss were shown a network, told that it was not traceable, and asked to draw one segment which would make the network traceable.

The content validity of the tests was judged to be satisfactory by a panel of mathematics educators. The reliability coefficients for the learning and two retentions tests as determined by the Kuder-Richardson Formula No. 20 are given in Table 1 for the groups that took the figural, verbal, or symbolic lessons. Correlation coefficients

Insert Table 1 about here

between each pair of tests was computed using Pearson product-moment correlation coefficient in an attempt to measure the similarity of the tests. The correlations are given in Table 2 for the groups that took the figural, verbal, or symbolic lessons. All correlations were significantly greater than zero.

Insert Table 2 about here

Procedures

The figurally oriented lesson was tested during the Spring Quarter 1972; the verbally oriented lesson during Fall Quarter 1972; and the symbolically oriented lesson during Winter Quarter 1972-73. Each quarter during the last class meeting before the experiment was begun Ss were informed that they were to be a part of an experiment, that the next three class meetings and part of two subsequent class meetings would be devoted to this experiment and that the results of the experiment would not affect their grade for the course. Ss were asked to give their cooperation.

The next two class periods the personological tests were administered and the following class period the Ss were given the instructional material and the Learning Test. They were given the entire class period (50 minutes) to read the instructional material and to complete the test. Exactly one week later Retention Test I was administered, and exactly four weeks after instruction Retention Test II was administered. Ss were given 15 minutes to complete each of the retention tests although most Ss completed them in 10-12 minutes.

Analysis of the Data

The mean and standard deviation of each of the twelve independent variables was computed and Ss were partitioned as to whether they were above or below the mean. t-tests were computed comparing the scores on each criterion test of Ss above the mean on each independent variable with Ss more below the mean. Table 3 contains the means and standard deviations of each group on each of the twelve independent variables and on the three criterion tests.

Insert Table 3 about here

Ss were assigned to either the X_i or the Y_i group depending on whether or not their score on variable i was above or below the mean variable. A t-test was then used to test the hypothesis. With each lesson there were twelve hypotheses, each stating that $\bar{x}_{x_i} = \bar{x}_{Y_i}$. A Biomed computer program BMDX70 was used to analyze the data (Dixon, 1970).

The selection of appropriate α level in this analysis was an important consideration. Cohen (1969) has observed that the power of a statistical test is a function of (1) the selected α level, (2) the sample size, and (3) the "Effect Size." Since the sample size depended upon the number of students enrolled in the course,

it was impossible to control. In order to reduce the possibility of a Type II error and in view of the relatively small sample sizes, an α-level of .10 was selected.

Findings and Conclusions

Figural Lesson

The "figural lesson" was given during the Spring Quarter 1972. Table 4 contains the means and standard deviations for the Learning Test of the Ss that were above or below the mean on each of the twelve independent variables. Table 4 also contains the t-scores for these groups. On the Learning Test only two of the hypotheses were rejected

Insert Table 4 about here

($p < .10$) -- Cognition of Figural Relations (CFR) and Total Cognition of Figural Content (CF-T).

Table 5 contains the means and standard deviations for Retention Test I of the Ss that were above or below the mean on each of the twelve independent variables. Table 5 also contains the t-scores for these

Insert Table 5 about here

groups. On Retention Test I only two of the hypotheses were rejected ($p < .10$) -- Cognition of Figural Relation (CFR) and Total Cognition of Figural Content (CF-T).

Table 6 contains the means and standard deviations for Retention Test II of the Ss that were above or below the mean on each of the twelve independent variables.t-scores for these groups are also in Table 6.

Insert Table 6 about here

On Retention Test II four of the hypotheses were rejected ($p < .10$) -- Cognition of Figural Classes (CFC), Cognition of Figural Relations (CFR), Total Cognition of Figural Content (CF-T), and Cognition of Symbolic Classes (CSC).

If this lesson were a figural lesson and not a verbal or symbolic lesson then one would expect to reject the hypotheses for the CFU, CFC, CFR, and CF-T variables (i.e., Ss with high figural ability would score significantly higher on the criterion tests than Ss with low figural ability) and fail to reject the hypotheses for the remainder of the variables (i.e., high verbal or symbolic ability Ss would not score significantly higher on the criterion tests than Ss with low verbal or symbolical ability). On each of the three tests (Learning Test, Retention Test I, and Retention Test II) the findings were in the anticipated direction on ten of the twelve variables. The results of this study support the hypothesis that the intended figurally oriented materials are indeed figurally oriented.

Verbal Lesson

The "verbal lesson" was given during the Fall Quarter 1972. Table 7 contains the means and standard deviations for the Learning Test of the Ss that were above or below the mean on each of the twelve independent variables. Table 7 also contains the t-scores for these groups. On the Learning Test only four of the hypotheses failed to be

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Insert Table 7 about here

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rejected ($p < .10$) -- Cognition of Figural Units (CFU), Cognition of Figural Relations (CFR), Cognition of Symbolic Units (CSU), and Cognition of Symbolic Classes (CSC). All four of the semantic variables were significant.

Table 8 contains the means and standard deviations for Retention Test I of the Ss that were above or below the mean on each of the twelve independent variables. t-scores for these groups are also in Table 8.

Insert Table 8 about here

On Retention Test I only one of the semantic variables failed to be significant ($p < .10$) -- Cognition of Semantic Units (CMU) while six of the figural or symbolic variables were significant.

Means and standard deviations and t-scores for Retention Test II of Ss that were above or below the mean on each of the twelve independent variables are in Table 9. Three of the verbal independent

Insert Table 9 about here

variables were significant at the .10 level (CMU, CMR, and CM-T) while four of the figural or symbolic variables were significant.

If this lesson were a verbal lesson and not a figural or symbolic lesson then one would expect to reject the hypotheses for the CMU, CMC, CMR, and CM-T variables and fail to reject the hypotheses for the remainder of the variables. On the Learning Test, Retention Test I, and Retention Test II, findings were in the anticipated direction on eight, five, and seven of twelve variables, respectively. The results of this study tend to support the hypothesis that the intended verbally oriented materials are verbally oriented. However, the results are not as distinctive as in the case of the figural lesson.

Symbolic Lesson

The "symbolic lesson" was given during the Winter Quarter 1972-73. Table 10 contains the means and standard deviations and t-scores for the Learning Test of the Ss who were above or below the mean on each of

the twelve independent variables. Table 10 also contains the t-scores

Insert Table 10 about here

for these groups. On the Learning Test three of the symbolic variables were significant ($p < .10$). However, four of the figural or verbal variables were also significant.

Table 11 contains the means, standard deviations, and t-scores for Retention Test I of the Ss who were above or below the mean on each of the twelve independent variables. On Retention Test I only one of the symbolic variables was significant ($p < .10$) -- Cognition of

Insert Table 11 about here

Symbolic Relations (CSR) and five of the eight figural or verbal variables were significant.

Means, standard deviations, and t-scores for Retention Test II of Ss who were above or below the mean on each of the twelve independent variables are in Table 12. One only of the symbolic variables was

Insert Table 12 about here

significant at the .10 level -- Cognition of Symbolic Relations (CSR). Five of the figural or semantic variables were not significant.

If this lesson were a symbolic lesson and not a figural or verbal lesson then one would expect to reject the hypotheses for the CSU, CSC, CSR, and CS-T variables and fail to reject the hypotheses for the remainder of the variables. On the Learning Test, Retention Test I, and Retention Test II findings were in the anticipated direction on

symbolically oriented and less figurally and verbally oriented.

One interesting finding was the increase in the mean scores from the beginning test to Retention Test I and from Retention Test I to Retention Test II (see Table 3). This increase occurred for all three lessons. A t-test was used to pairwise compare the means for each lesson. Results of this t-test are in Table 13. The t-statistic

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Insert Table 13 about here

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between the Learning Test and Retention Test I is significant at the .10 level for both the figural lesson and the verbal lesson. The t-statistic between the Learning Test and Retention Test II is significant at the .10 level for all three lessons. There are several possible explanations for this phenomenon. (1) It could be the result of practice since the retention tests were very similar to the learning test. (2) There may have been interaction among Ss in the days following each of the first two tests. (3) Ss may have reflected upon their experience and discovered the critical criterion after taking the learning test. (4) Each retention test was easier than the preceeding tests. In all likelihood all of the first three factors were involved. The last factor can be tested by rearranging the order of the tests in subsequent experimentation.

Based upon the results of this study, the experimenters feel confident in testing the figural and verbal lessons for aptitude treatment interaction. However, revisions of the verbal and symbolic lessons will be undertaken in attempts to make them receptive to Ss with these styles of learning.

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TABLE 1

RELIABILITY COEFFICIENTS FOR
TEST 1, TEST 2, AND TEST 3

	Figural Lesson	Verbal Lesson	Symbolic Lesson
Learning Test	.79	.80	.79
Retention Test I	.71	.82	.76
Retention Test II	.79	.87	.82

TABLE 2

WITHIN GROUP CORRELATION COEFFICIENTS FOR
TEST 1, TEST 2, AND TEST 3

Variables	Figural Lesson			Verbal Lesson			Symbolic Lesson		
	1	2	3	1	2	3	1	2	3
1. Learning Test		.73*	.66*		.83*	.73*		.80*	.80*
2. Retention Test I			.74*			.75*			.77*
3. Retention Test II									

* $p < .05$

TABLE 3

MEANS AND STANDARD DEVIATIONS FOR ALL Ss FOR EACH INDEPENDENT VARIABLE AND EACH CRITERION TEST

Trigram	Independent Variable	Figural Lesson			Verbal Lesson			Symbolic Lesson		
		N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
CFU	Cognition of figural units	88	9.69	2.93	86	10.59	3.21	68	10.76	3.90
CFC	Cognition of figural classes	88	7.19	3.12	86	7.67	2.84	68	11.44	2.88
CFR	Cognition of figural relations	88	12.87	3.46	86	13.50	3.71	68	13.07	3.14
CF-Tot	Total Cogniton of figural cont.	88	29.64	6.63	86	31.77	6.51	68	35.28	6.39
CMU	Cognition of semantic units	88	14.13	4.03	86	15.52	3.74	68	12.97	3.35
CMC	Cognition of semantic classes	88	22.26	3.67	86	23.83	4.01	68	22.31	3.99
CMR	Cognition of semantic relations	88	6.09	1.68	86	6.48	1.72	68	6.18	1.78
CM-Tot	Total Cognition of symantic cont.	88	42.81	6.72	86	45.83	6.35	68	41.46	6.43
CSC	Cognition of symbolic classes	88	7.59	2.03	86	8.06	2.38	68	7.81	2.13
CSU	Cognition of symbolic units	88	16.82	4.82	86	17.94	4.92	68	17.88	4.54
CSR	Cognition of symbolic relations	88	11.08	3.76	86	11.85	3.79	68	11.57	3.30
CS-Tot	Total Cognition of symbolic cont.	88	35.58	8.40	86	37.85	8.28	68	37.26	7.93
	Learning Test	88	9.74	3.65	86	10.14	3.57	68	8.81	3.55
	Retention Test I	86	11.22	2.89	78	10.96	3.59	53	9.43	3.75
	Retention Test II	81	11.46	3.25	75	11.03	3.87	58	9.84	3.75

TABLE 4

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF FIGURAL LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON THE LEARNING TEST

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	34	9.47	3.93	54	9.91	3.48	0.54
CFC	45	9.64	3.68	43	9.84	3.65	0.25
CFR	41	8.61	3.24	47	10.72	3.73	2.82*
CF-T	42	8.69	3.58	46	10.70	3.47	2.67*
CMU	46	9.83	3.56	42	9.64	3.78	-0.23
CMC	44	9.98	3.71	44	9.50	3.61	-0.61
CMR	53	9.58	3.82	35	9.97	3.41	0.48
CM-T	39	9.67	3.68	49	9.80	3.66	0.16
CSU	39	9.72	3.93	49	9.76	3.45	0.05
CSC	41	9.22	3.87	47	10.19	3.42	1.25
CSR	43	9.30	3.92	45	10.16	3.36	1.10
CS-T	42	9.57	3.86	46	9.89	3.47	0.41

* $p < .10$

TABLE 5

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF FIGURAL LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON THE RETENTION TEST I

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	33	10.61	2.94	53	11.61	2.82	1.57
CFC	44	11.09	2.84	42	11.36	2.98	0.42
CFR	40	10.20	2.33	46	12.11	3.06	3.22*
CF-T	41	10.34	2.45	45	12.02	3.06	2.80*
CMU	45	11.42	2.62	41	11.00	3.18	-0.67
CMC	43	10.93	3.04	43	11.51	2.75	0.93
CMR	51	11.22	2.80	35	11.23	3.06	0.02
CM-T	38	10.71	3.11	48	11.62	2.67	1.47
CSU	37	11.35	2.89	49	11.12	2.92	-0.36
CSC	40	11.12	2.63	46	11.30	3.13	0.29
CSR	42	10.86	2.85	44	11.57	2.92	1.14
CS-T	41	11.00	2.90	45	11.42	2.90	0.67

* $p < .10$

TABLE 6

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF FIGURAL LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON THE RETENTION TEST II

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	32	11.53	3.18	49	11.41	3.32	-0.17
CFC	39	10.77	3.21	42	12.10	3.19	1.86*
CFR	38	10.37	3.04	43	12.42	3.15	2.97*
CF-T	38	10.34	3.09	43	12.44	3.10	3.05*
CMU	42	11.40	3.10	39	11.51	3.44	0.15
CMC	41	11.05	2.96	40	11.88	3.51	1.15
CMR	50	11.34	3.32	31	11.65	3.18	0.41
CM-T	38	10.97	3.17	43	11.88	3.30	1.26
CSU	36	11.53	3.45	45	11.40	3.11	-0.17
CSC	38	10.63	3.27	43	12.19	3.09	2.20*
CSR	42	11.17	3.05	39	11.77	3.46	0.83
CS-T	39	10.92	3.16	42	11.95	3.28	1.43

* $p < .10$

TABLE 7

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF VERBAL LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON THE LEARNING TEST

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	41	10.07	3.60	45	10.20	3.58	0.16
CFC	37	9.08	3.34	49	10.94	3.56	2.46*
CFR	37	9.81	3.63	49	10.39	3.55	0.74
CF-T	38	8.97	3.15	48	11.06	3.65	2.80*
CMU	43	9.49	3.67	43	10.79	3.38	1.71*
CMC	30	9.23	3.37	56	11.62	3.61	1.74*
CMR	45	9.22	3.58	41	11.45	3.32	2.58*
CM-T	36	9.06	3.57	50	10.92	3.40	2.46*
CSU	48	10.02	3.68	38	10.29	3.48	0.34
CSC	39	9.62	3.89	47	10.57	3.26	1.24
CSR	39	8.69	2.99	47	11.34	3.60	3.66*
CS-T	43	9.02	3.43	43	11.26	3.40	3.04*

* $p < .10$

TABLE 8

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF VERBAL LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON THE RETENTION TEST I

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	36	11.28	3.58	42	10.69	3.63	-0.72
CFC	34	9.91	3.72	44	11.77	3.31	2.33*
CFR	33	10.73	3.72	45	11.13	3.53	0.49
CF-T	34	9.82	3.44	44	11.84	3.50	2.54*
CMU	40	10.50	3.15	38	11.45	4.00	1.17
CMC	24	9.75	3.77	54	11.50	3.41	2.02*
CMR	40	10.05	3.37	38	11.92	3.62	2.37*
CM-T	32	9.84	3.36	46	11.74	3.58	2.36*
CSU	42	10.33	3.84	36	11.69	3.19	1.69*
CSC	35	9.91	3.79	43	11.81	3.22	2.39*
CSR	33	9.82	3.26	45	11.80	3.63	2.49*
CS-T	38	9.42	3.43	40	12.42	3.14	4.04*

*$p < .10$

TABLE 9

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF VERBAL LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON THE RETENTION TEST II

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	35	10.83	3.79	40	11.20	3.97	0.41
CFC	32	10.34	3.93	43	11.53	3.78	1.33
CFR	33	10.15	4.07	42	11.71	3.60	1.76
CF-T	33	9.39	3.67	42	12.31	3.55	3.48*
CMU	35	10.14	3.44	40	11.80	4.09	1.88*
CMC	25	10.24	4.18	50	11.42	3.68	1.25
CMR	39	9.69	3.80	36	12.47	3.43	3.31*
CM-T	30	9.70	3.73	45	11.91	3.73	2.51*
CSU	40	10.80	4.05	35	11.29	3.69	0.54
CSC	35	10.17	4.19	40	11.78	3.44	1.82*
CSR	34	9.41	3.66	41	12.37	3.54	3.54*
CS-T	37	9.78	3.84	38	12.24	3.54	2.88*

*$p < .10$

TABLE 10

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF SYMBOLIC LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON THE LEARNING TEST

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	31	8.29	3.46	37	9.24	3.62	1.10
CFC	33	7.45	3.31	35	10.09	3.33	3.27*
CFR	37	8.19	3.13	31	9.55	3.92	1.59
CF-T	35	8.00	3.26	33	9.67	3.69	1.98*
CMU	35	8.11	3.55	33	9.55	3.45	1.68*
CMC	32	8.09	3.44	36	9.44	3.57	1.58
CMR	39	8.44	3.44	29	9.31	3.70	1.00
CM-T	35	7.89	3.28	33	9.79	3.61	2.28*
CSU	30	8.67	3.85	38	8.92	3.34	0.29
CSC	30	8.00	3.69	38	9.45	3.35	1.69*
CSR	37	7.68	3.41	31	10.16	3.28	3.05*
CS-T	30	7.73	3.71	38	9.66	3.22	2.29*

*p < .10

TABLE 11

MEANS, STANDARD DEVIATIONS AND t-TEST RESULTS OF SYMBOLIC LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON RETENTION TEST I

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	26	8.77	3.46	27	10.07	3.98	1.27
CFC	28	8.14	3.49	25	10.88	3.56	2.82*
CFR	27	8.59	3.62	26	10.31	3.76	1.69*
CF-T	29	8.41	3.56	24	10.67	3.68	2.26*
CMU	30	8.67	3.99	23	10.43	3.23	1.73*
CMC	25	8.68	3.76	28	10.11	3.68	1.39
CMR	33	8.97	3.95	20	10.20	3.36	1.21
CM-T	28	8.07	3.70	25	10.96	3.25	3.00*
CSU	24	9.08	4.22	29	9.72	3.37	0.61
CSC	25	8.56	3.55	28	10.21	3.82	1.63
CSR	31	8.42	3.50	22	10.86	3.71	2.44*
CS-T	25	8.92	3.75	28	9.89	3.76	0.94

*$p < .10$

TABLE 12

MEANS, STANDARD DEVIATIONS, AND t-TEST RESULTS OF SYMBOLIC LESSON GROUPS ABOVE OR BELOW THE MEAN FOR EACH INDEPENDENT VARIABLE ON RETENTION TEST II

Independent Variable	Ss < $\bar{x}$			Ss > $\bar{x}$			t
	N	Mean	S.D.	N	Mean	S.D.	
CFU	26	9.04	3.54	32	10.50	3.85	1.49
CFC	31	8.65	3.47	27	11.22	3.65	2.75*
CFR	31	8.61	3.56	27	11.26	3.53	2.84*
CF-T	31	8.52	3.30	27	11.37	3.72	3.10*
CMU	30	9.20	3.67	28	10.54	3.79	1.36
CMC	27	9.56	3.58	31	10.10	3.94	0.54
CMR	34	9.59	3.73	24	10.21	3.84	0.62
CM-T	30	9.20	3.50	28	10.54	3.96	1.36
CSU	25	9.32	4.45	33	10.24	3.44	0.93
CSC	24	9.00	3.44	34	10.44	3.89	1.45
CSR	31	8.90	3.30	27	10.93	3.98	2.11*
CS-T	24	9.21	3.59	34	10.29	3.86	1.09

*$p < .10$

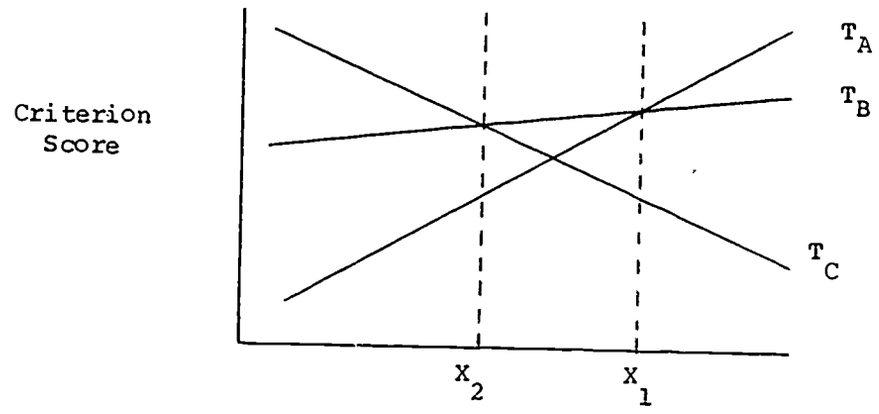
TABLE 13

Lesson	Learning Test			Retention Test I			Retention Test II			t
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	
	88	9.74	3.65	86	11.22	2.89				2.96**
Figural	88	9.74	3.65				81	11.46	3.25	3.22**
				86	11.22	2.89	81	11.46	3.25	0.50
	86	10.14	3.57	78	10.96	3.59				1.47*
Verbal	86	10.14	3.57				75	11.03	3.87	1.52*
				78	10.96	3.59	75	11.03	3.87	0.12
	68	8.81	3.55	53	9.43	3.75				0.93
Symbolic	68	8.81	3.55				58	9.84	3.75	1.58*
				53	9.43	3.75	58	9.84	3.75	0.58

* $p < .10$

** $p < .05$

(a)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T_C
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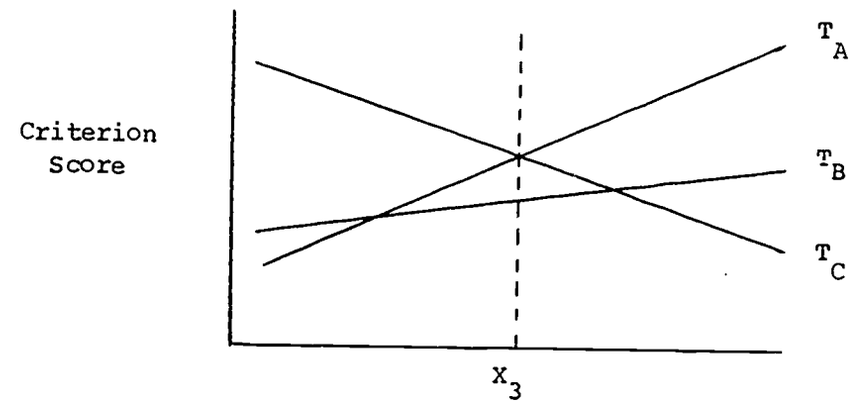
Aptitude Score

(b)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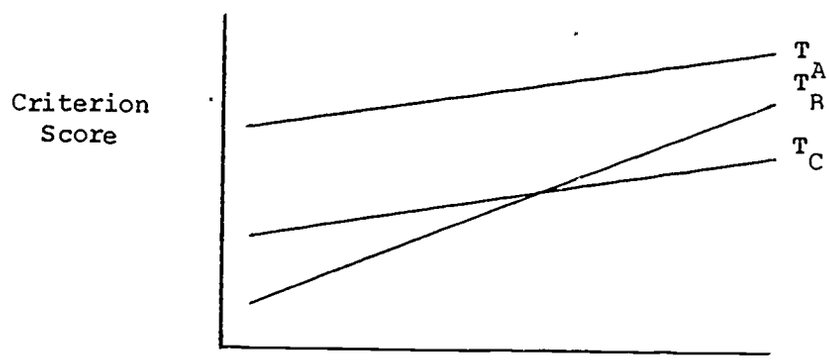
T_B
T_C
X_3
Aptitude Score

(c)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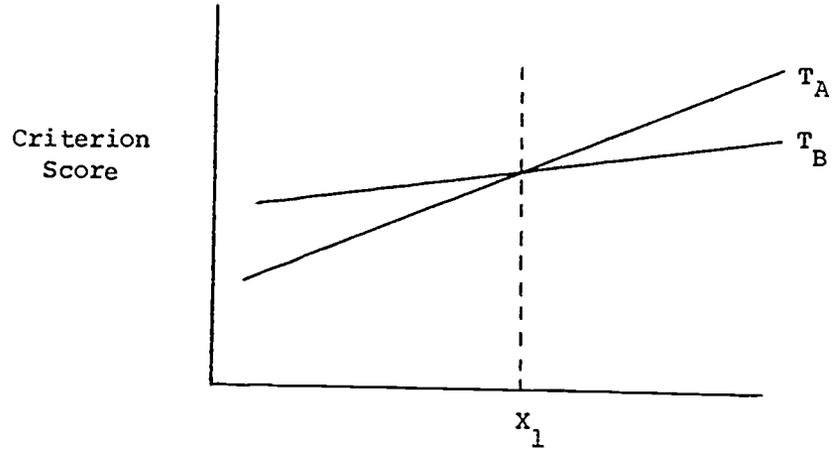
Aptitude Score

FIGURE 1

(a)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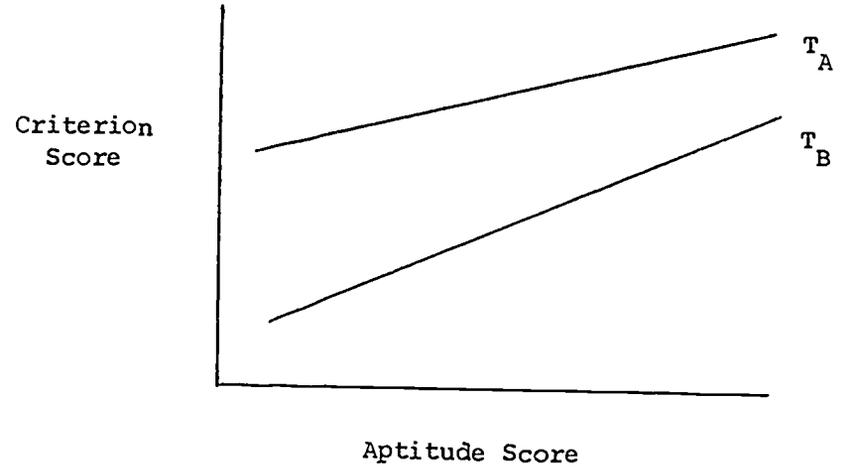
Criterion Score
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T_B
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FIGURE 2